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the map almost due east of Lexington, and distant 51 miles.

Two other saplings in the vicinity of where No. 3 fell, distant, respectively, about 100 and 200 yards, in an easterly direction, have been broken off by missiles striking them from the west. Search for where these buried themselves in the ground was not rewarded with success.

The dent in the road made by No. 1 had become obliterated, but from the accounts of those who saw it soon after it was made, it dipped eastward, and so is in line with the evidence afforded by the other fragments.

ARTHUR M. MILLER.

STATE COLLEGE OF KENTUCKY.

THE PROTECTIVE FUNCTION OF RAPHIDES.

TO THE EDITOR OF SCIENCE: In view of Dr. Wiley's interesting account (printed in SCIENCE of July 24) of the raphides of *Colocasia antiquorum*, it may be worth while to quote the description of these crystals and the cells containing them given by Haberlandt in his 'Physiologische Pflanzenanatomie,' edition 2, pp. 448, 449, 1896, translating literally:

"That in numerous cases the crystals of calcium oxalate, when they occur as raphides or spear-shaped crystals, are also to be regarded as functioning secondarily as a mechanical means of protection against animals that would feed upon the plant, is beyond doubt. Schroff has proved that the irritating effect of the sap of the bulb of *Scilla maritima* depends upon the penetration of the skin by the raphides, and that filtered sap produces no irritation. Stahl* afterwards demonstrated the same thing as holding true for other plants, especially *Arum maculatum*, and showed by experiment that leaves of that plant, when merely treated with alcohol, were hardly touched by snails, while on the other hand, leaves treated with dilute hydrochloric acid,

in which the raphides were dissolved, were very quickly devoured. The ejection of the numerous crystal needles from the cell containing them is largely effected through the absorption of water by the strongly swelling mucilaginous substance which always encloses the bundle of raphides. That the form of the containing cell, as well as the manner in which its walls are thickened, is in many cases an adaptation to the protective function of the raphides, is indicated by the following example.

"In the leaves of *Pistia Stratiotes* [which like *Colocasia* and *Arisæma* belongs to the Arum family], the one-layered plates of parenchyma that make up the aerenchyma (breathing tissue) contain transversely placed, spindle-shaped, elongated cells [almost cigar-shaped in Haberlandt's figure] containing raphides. Both ends of these cells project into the intercellular air spaces. The blunt ends of these cells have an extremely delicate cell wall, while the rest of the cell wall is rather thick, although not cutinized. Upon mechanical injury to the cell, although not, however, through the simple presence of water, the raphides are ejected, generally one at a time, with considerable force through the swelling mucilaginous envelope, whereby the thin portion of the cell wall is pierced and soon completely disappears. The place of exit of the raphides is in this case determined by the thin part of the wall and, furthermore, the conical tapering of the ends of the cells prevents the whole bundle of raphides being ejected at once. As the raphides are projected one after the other, the attacking animal can be wounded in different parts of the body."

THOS. H. KEARNEY.

SHORTER ARTICLES.

CARBONIFEROUS FOSSILS IN 'OCOEE' SLATES IN ALABAMA.

THE age of the semi-crystalline and crystalline schists which extend in continuous belt from New England to Alabama, has long been a subject of discussion and of wide difference of opinion among geologists. On the one hand, they have been considered as pre-Cambrian;

* The utility of raphides in protecting plants from snails is quite fully discussed by Stahl in his interesting paper entitled 'Pflanzen und Schnecken: Eine biologische Studie über die Schutzmittel der Pflanzen gegen Schneckenfrass,' *Jenaischen Zeitschrift für Naturw. und Med.*, Vol. 22, pp. 84-99 of the reprint.

on the other, they have been identified as metamorphosed Paleozoic sediments. At the northern end of this belt it has been possible, by means of the fossils, by tracing them into unaltered fossiliferous beds, and by their stratigraphic relations, to assign parts of these slates to Paleozoic formations. Thus the 'Archæan' of southeastern New York has been proved to be largely of Cambrian and Ordovician age, and the highly crystalline mica schists of New York island are now assigned to the Hudson river horizon. Further southward in Pennsylvania and Maryland a similar change in the reference seems to be taking place, as is evidenced by the recent work of Miss Bascom.

The semi-metamorphic slates and conglomerates constituting the Ocoee of Dr. Safford have in like manner been variously classified. Dr. Safford considered them as of Silurian (Cambrian) age, but as occupying a position below the oldest of his fossiliferous Silurian divisions, the Chilhowee. Mr. Arthur Keith at one time, from their superposition and structure, reached the conclusion that these rocks were in part at least of Carboniferous age, but detailed mapping and study of the sedimentary formations of the North-Carolina-Tennessee mountains and the tracing of the different layers from place to place, have enabled him to prove to the satisfaction of the geologists conversant with that region that the Ocoee strata along or near the state boundary line are of Cambrian age, and correspond in the main to the lower part of the section shown in Chilhowee Mountain. In this he confirms Dr. Safford.

Mr. E. C. Eckel, in papers* dealing with the gold deposits of the Dahlonega district of Georgia, has suggested incidentally that both the Ocoee rocks proper and the more highly metamorphosed rocks east of them are probably of Paleozoic age, and may possibly be in part of late Paleozoic age; while the Dahlonega gold deposits were certainly formed not earlier than the Ordovician and possibly as late as the Carboniferous. These conclu-

sions were based upon the structural relations of the deposits, and were supported by analogy with similar rocks and deposits in Tennessee, Virginia and New York.

From these notes it will appear that conclusions as to the age of the Ocoee have heretofore been based upon their stratigraphy and structure, *i. e.*, upon circumstantial evidence, and it will, no doubt, be of interest to readers of SCIENCE to know that we have now *definite paleontological evidence* of the age of a part, at least, of these rocks.

In November, 1902, I received from Mr. Joshua Franklin, of Mosely, Clay County, Ala., some fossils obtained by him from the slates near his house. These were submitted to Mr. David White, of the National Museum, for identification, but it was not until May of the present year that I had the opportunity of visiting the locality and noting the mode of occurrence of the fossils. The locality is at the eastern base of the main range of the Talladega Mountains and at a distance of eight miles or more from the contact of the 'Ocoee' with the unaltered Cambrian of the valley. The slates in which the fossils are found are the ordinary semi-crystalline (sericite) slates of the Ocoee type. At the point in question these slates are in places highly charged with graphitic matter, which is particularly in evidence in freshly exposed rocks in a railroad cut. Where they have been long exposed at the surface they have lost in great measure this graphitic matter and are of the usual bluish and yellowish colors and silky luster. The fossils are mostly found in concretions, usually lens-shaped, but occasionally longer in one dimension; the concretions are very perceptibly lighter in specific gravity than the rock itself; when broken open they are sometimes found to hold badly preserved organic forms; sometimes they are hollow, the organic matter having apparently been removed by decay, leaving only a loose powdery silicious residue filling only a part of the cavity. Other fossils, and among them the most perfect one (a *Lepidostrobus*), are found loose, and, while they have not yet been specifically identified, appear to be pieces of stems

* *Engineering and Mining Journal*, February 7, 1903; Bull. 213 U. S. Geol. Survey.

of *Lepidodendron*, *Calamites* and *Artisia*. Like the concretions, these fossils are generally considerably lighter in weight than the ordinary rock. It is interesting also to note that I found several thin veins of turquoise in the slates of the railroad cut above mentioned. The same mineral had been previously observed in thin veins in a much more highly crystalline mica schist a few miles distant from this locality. Mr. Franklin has also given me a piece of quartz showing free gold which he says he found in the same slates that carry the fossils, and indeed in the near vicinity of this find, precisely similar slates, to all appearance, carry quartz veins that have been worked for gold for many years. I collected the fossils along this belt of slates for a distance of a mile or more, and while they are not particularly abundant, I was able in the course of an hour to get fifty or more specimens.

Mr. David White, to whom the best specimens were sent, writes me as follows: "The fossils you sent me are most interesting and important on account of their bearing on the classification of the formation from which they were derived. The biological problem is hardly less interesting to me, for it is but the second lepidophytic cone fragment showing microscopical structure that has turned up in our Paleozoics, so far as I am aware. Another larger specimen in hand is from a Carboniferous limestone in the Indian Territory. Your specimens represent several fragments of large cones in which the axes, the basal, sporangiferous portions of the spirally arranged bracts, the rhomboidal compressed sporangia and the megaspores are well defined. Precise identification of the material is deferred pending the study of thin sections and the determination of certain points regarding the sporangial walls and their attachment to the basal portions of the bracts. It is clear, however, that we have here fragments of cones whose superficial features appear to represent the common *Lepidostrobus* type of the upper Paleozoic. Beds containing lepidophytic remains of this type can hardly be

older than Devonian at earliest, and should not antedate the Middle Devonian.

"The general proportions and aspect of the cones are suggestive of some of the Carboniferous forms. Although the internal structure of the strobili may be found to indicate a more highly organized genus than *Lepidostrobus*, we may rest assured that the material is not older than the Upper Paleozoic lepidophytes."

We can now safely say that the Ocoee of Alabama includes the metamorphosed sediments of more than one of the Paleozoic formations, but it may be doubted if conclusive paleontological evidence of the age will be found in many cases, since the fossils will inevitably be obliterated in all the more highly crystalline of these schists.

EUGENE A. SMITH.

UNIVERSITY OF ALABAMA,
June 6, 1903.

BOTANICAL NOTES.

TWO INTERESTING PARASITIC PLANTS.

IN a recent bulletin of the Kentucky Experiment Station, Professor Garman describes two parasitic plants which are considerably out of the ordinary line. They are the broomrapes of the genus *Orobanche*. They are small plants related to the figworts, but destitute of any green color. Their roots are attached to the roots of various plants, and in this way they steal the food matters which, were they honest, they would secure for themselves from the soil and air. The first species described, *O. ramosa*, is parasitic to a considerable extent on tobacco and hemp in Kentucky, doing a good deal of damage. The second is *O. ludoviciana*, a native species very common on the western plains. This is also found to be parasitic on the hemp in Kentucky. These two species have been carefully investigated by Professor Garman, and he makes some suggestions in regard to their eradication. He finds that is impracticable to remove the parasites from the growing crop of hemp, but it is practicable to remove them from the tobacco crop. It is found impracticable to remove the rape seeds from hemp seed by flotation. Soak-